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Abstract

In this paper we asses whether productivity growth differentials between the U.S. and Europe in the distributive trade sector are real or mainly a statistical myth. New estimates of retail trade productivity are constructed, taking into account purchase prices of goods sold. We also adjust U.S. wholesale productivity growth for the upward bias due to the use of constant-quality prices of ICT-goods sales. We find that multifactor productivity growth in the U.S. has been higher than in Europe after 1995, but that this lead is smaller than suggested by national accounts based estimates. This finding is robust for various productivity measurement models.

1. Introduction

Europe's growth performance has been the subject of increasing scrutiny over recent years. The Lisbon target to make the European Union (EU) the most dynamic and competitive economy in the world by the year 2010 seems hard to achieve. While average annual labour productivity growth in the U.S. accelerated from 1.3% during the period 1980-1995 to 1.9% during 1995-2003, growth in the European Union declined from 2.3% to 1.3%. A detailed sectoral perspective on growth suggests that performance in distributive trade is at the heart of the widening productivity gap between the two regions. In fact, over half of the economy-wide labour productivity growth lead of the U.S. over Europe after 1995 can be traced to strong U.S. performance in wholesale and retail trade (van Ark, Inklaar and McGuckin, 2003). One reason is that distributive trading activities are a major part of the economy: in OECD economies they account on average for about 15% of employment and 10% of GDP. The second reason is that the trade sector has experienced a significant acceleration in multifactor productivity growth around 1995 in the U.S., but not in Europe (Jorgenson, Ho and Stiroh 2003; Triplett and Bosworth 2004, Inklaar, O'Mahony and Timmer 2003).

Various studies have discussed the reasons for superior performance in U.S. trade industry. Most focused on the role of ICT as a source of productivity growth and stress Europe's lagging behind in ICT investment and accompanying organisational changes (McKinsey Global Institute 2002; Baily and Kierkegaard, 2004; McGuckin, Spiegelman and van Ark 2005). In the U.S. rapidly increasing market share of new retail formats has led to high labour productivity growth, both because of increased competitive pressure on incumbent firms and the supposedly higher levels of efficiency of the new entrants (Foster, Haltiwanger and Krizan 2002). Others have primairily emphasised the role of "big box" formats as exemplified most notably by the emergence of Wal-Mart as the engine of productivity growth in U.S. retailing. From this perspective, Europe's lagging behind is due to more restrictive regulations concerning for example zoning and labour markets, and cultural differences (Gordon, 2004).

In this paper we take one step back and raise a more down-to-earth question: to what extent is superior productivity growth in U.S. distribution real? Or is it a statistical myth due to incomparable data and inadequate measurement methods? The latter has been suggested by a recent report of the European Commission (2004) and was also raised by Gordon (2004). Both stress the statistical problems with measures of productivity in trade sectors and argue for a critical assessment of the way in which volume measures of trade output are being calculated. The European Commission report claims that the contribution of trade sectors to the U.S. productivity boom is substantially overestimated. Thus, attention is shifted away from Europe's lack of efficient ICT adoption in services, to Europe's lagging behind in ICT goods production.

Despite some useful clues from recent studies on U.S. measurement of retail service output (Triplett and Bosworth 2004, Manser 2004) this subject has not been investigated in-depth in an international comparative perspective. In our view, productivity growth estimates based on national accounts data are becoming more and more obsolete, due to organizational changes in trading, and suffer increasingly from comparability problems, due to statistical measurement innovations. There are two main problems. First, the trade output concept used in the system of national accounts (SNA) is the margin concept. Costs of goods sold are not included in intermediate consumption. But recent changes in business models of retailing and wholesaling are pervasive. In particular, the demarcations of activities between traders, manufacturers and customers are shifting. A simple example taken from Triplett and Bosworth (2004) is provided by the sale of bicycles, which once were delivered to the retailer fully assembled. Now they typically arrive in a box, and customers can choose between having the store arrange for assembly or doing it themselves. Hence sales should be used as the point of departure in productivity measurement rather than margins (Triplett and Bosworth 2004, Manser 2004). We show that productivity measures based on sales or margins differ only by a scalar in case margins are double deflated, that is when goods sold and purchased are separately deflated. However, in the current statistical system margins are not double deflated.

This introduces a second problem for productivity measures based on national accounts data. Due to the use of quality-adjusted prices for deflation of goods sold and the lack of (quality adjusted) prices for goods purchased, productivity growth in the trade sector will be upwardly biased. This is similar to the point stressed by Triplett (1996) in his study of productivity growth rates in computer manufacturing. Given the fact that the use of quality-adjusted prices by statistical offices is rapidly increasing, this problem recently gained importance. Presently, it appears most visible in measurement of computer sale margins. For example, nominal sales of the electronics stores (US NAICS 4431) grew on average at 5% per year in the U.S. during 1995-2002. The prices of these products, about half of which are computers, declined on average at an annual rate of 12% as measured by quality-adjusted price indices. As a result, sales volume grew by a phenomenal 17% annually. In the national accounts, margin volumes are assumed to grow at the same 17 % rate.

Countries will differ in the extent to which quality-adjusted prices are used to measure trade margins. How this affects the comparability of productivity estimates across countries is still a black box, and has not gone much beyond speculations so far. The problem bears resemblance to the one that received a lot of attention in comparative studies of aggregate economic growth in the 1990s. Wyckoff (1995) pointed to the fact that deflators of ICT-investment varied across countries due to differences in the methods used to adjust prices for quality changes. Schreyer (2002) discussed the consequences for international comparability of measures of GDP and its components. Among others, it was found that growth of ICT investment volumes in Europe was underestimated compared to the U.S. In this paper we will provide a first attempt to quantify the magnitude of these measurement issues for international comparisons of productivity in trade industries.

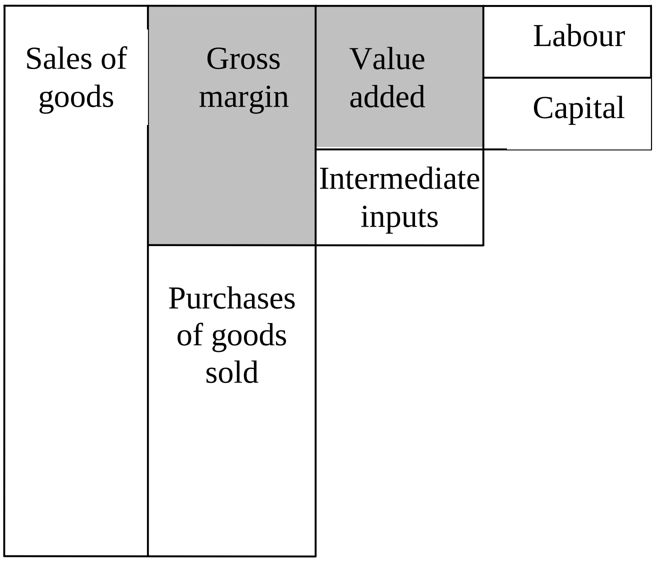
The remainder of this paper is organised as follows. In Section 2 we lay out a conceptual framework for measures of productivity in trade industries based on a neo-classical model of production and various concepts of output: sales, margins and value added. It is shown that multifactor productivity measures based on the various output concepts differ only by a scaling factor which is proportional to the share of value added and margin in sales. However, this is only true when all inputs are deflated with appropriate price indices. This is not the case in standard national accounting. In Section 3 we make an estimate of the bias due to the more widespread use of hedonic price indexes for deflating ICT-sales in the U.S. statistical system in comparison with European countries. We find some evidence for upward biases in relative growth of trade sales, especially in U.S. wholesaling. In Section 4, this measurement problem is tackled in a more fundamental way for the retail sector, focusing on margin volume measures. We provide an experimental approach to measure trade margins in constant prices, by applying a double deflation procedure to sales and purchases of goods sold. This is done for the U.S. and for four large European countries: France, Germany, the Netherlands and the United Kingdom. In Section 5 international comparisons of multifactor productivity are made, based on national accounts figures and our internationally harmonised measures of trade output and inputs. Our main conclusion is that comparative output and productivity growth in U.S. trade industries may be somewhat upwardly biased when based on national accounts figures. After correcting for these upward biases, U.S. productivity growth rates in the trade sector since the mid 1990s are still above European growth rates. This is mainly due to superior performance in retailing. Multifactor productivity performance in U.S. wholesaling is not out of line with European performance. Section 6 concludes.

2. Models for multifactor productivity measurement

Productivity is simply defined as a ratio of outputs over inputs. Basically, one can choose between three output concepts in the trade sector: sales, margins and value added. This is different from other sectors (e.g. manufacturing) for which only a distinction is made between production and value added.[1] Margins are defined as the difference between the value of the goods sold (sales) and the value of the goods that would need to be purchased to replace them.[2] Gross value added is derived by subtracting costs of intermediate inputs from gross trade margins. Value added consists of compensation for labour and capital inputs. The relationship between the various output concepts is depicted in Figure 1.

[1] For simplicity we omit the role of inventory changes.
[2] According to the System of National Accounts (SNA 1993) and the European System of Accounts (ESA 1995).

Figure 1
Output, Margin, Input and Value Added Concepts in Distributive Trades



There is a clear consensus that single input productivity measures, such as labour productivity, should be based on value added.[3] Here we deal with multifactor productivity (MFP) measures which include two or more inputs. For MFP measurement the natural point of departure is sales (Triplett and Bosworth 2004). We start with setting up a general model of producer behaviour in the trade sector following Jorgenson, Gollop and Fraumeni (1987). A full model of production would give the quantities of sales (q^S) as a function F of quantities of goods purchased for resale (q^C), intermediate inputs (q^{II}), capital input (q^K), labour input (q^L) and technology, indexed by time T.

$$q^S = F(q^C, q^{II}, q^L, q^K, T) \qquad (1)$$

Assuming a translog production function with constant returns to scale, the necessary conditions for producer equilibrium lead to the following discrete approximation of the change in sales quantities:

$$\dot{q}^S = \dot{A}^S + w^L \dot{q}^L + w^K \dot{q}^K + w^{II} \dot{q}^{II} + w^C \dot{q}^C \qquad (2)$$

This is the well-known growth accounting identity with $\dot{q}$ denoting a (logarithmic) quantity change and w^X the share of each input X in total sales: $w^L + w^K + w^{II} + w^C = 1$, and A^S multifactor productivity (MFP) which is a measure of technological change ($\partial F/\partial T$). The weights are period averages. MFP growth rates can be derived as a residual by:

$$\dot{A}^S = \dot{q}^S - w^L \dot{q}^L - w^K \dot{q}^K - w^{II} \dot{q}^{II} - w^C \dot{q}^C \qquad (3)$$

[3] See OECD (2001) for a good overview of various productivity measures.

This is the favoured set-up of trade sector productivity measurement by e.g. the BLS (Bureau of Labour Statistics) in its productivity program; Triplett and Bosworth 2004 and Oi 2000. It shows that MFP growth is the difference between the sales quantity growth and a weighted average of the growth in quantities of primary factor inputs (capital and labour), quantities of intermediate inputs and quantities of goods purchased for resale. However, when countries differ in the extent to which quality-adjusted prices are used to estimate volume growth of sales, MFP growth rates based on national accounts data will not be comparable across countries. We will show in the next section that this is indeed the case, especially for wholesaling.

In addition, there is a fundamental shortcoming of the available statistics collected within the framework of the System of National Accounts (SNA) which also threatens international comparability. From the National Accounts point of view the activities of the trade sector are seen as shifting boxes from producers to consumers. The goods purchased for resale are not treated as part of their intermediate consumption. Output is measured by margins and sales are not reported. Hence only margins can be the point of departure. In this model, the margin (q^M) is produced by factor and intermediate inputs as follows

$$q^M = G(q^{II}, q^L, q^K, T) \qquad (4)$$

Under the same assumptions as above, a MFP measure based on margin output (A^M) can be derived as follows

$$\dot{A}^M = \dot{q}^M - v^L \dot{q}^L - v^K \dot{q}^K - v^{II} \dot{q}^{II} \qquad (5)$$

with v^X the share of each input in total margin: $v^L + v^K + v^{II} = 1$. This margin model is a restricted version of the full production model. Effectively one assumes separability between goods purchased for resale and the various other inputs. It does not allow for substitution possibilities between capital, labour and intermediate inputs on the one hand, and goods purchased on the other. This is overly restrictive and runs counter current trends in retailing practice where the potential for this kind of substitution is rapidly increasing. A simple example is provided by the sale of bicycles, which once were delivered to the retailer fully assembled. Now they typically arrive in a box, and customers can choose between having the store arrange for assembly or doing it themselves.[4]

In theory, MFP based on margins or sales differ only by a scalar as long as the margin is measured by means of double deflation. That is, when the margin growth is measured as the difference between growth of sales and growth of goods purchased, each deflated by their own price index. Let

$$\dot{q}^M = \frac{1}{w^M}\left(\dot{q}^S - (1 - w^M)\dot{q}^C\right) \qquad (6)$$

with w^M the share of margin in total sales. In this case there is a simple relationship between MFP measures of the full (sales based) and the restricted (margin) model. Substituting (6) in (5) and using (3) one can easily show that they differ only by a scalar [5]

$$\dot{A}^M = \frac{1}{w^M}\dot{A}^S \qquad (7)$$

For double-deflated margins, prices of both sales and purchases of goods for resale are needed. Unfortunately, neither quantities nor prices of goods purchased for resale are extensively collected within the official statistical systems. Instead, standard statistical practice is to derive real margin growth by assuming that the volume of margins follows the volume of sales: $\dot{q}^S = \dot{q}^M$.[6] In this case, the MFP measure based on national accounts data ($\dot{A}^M_{NA}$) is as follows:

$$\dot{A}^M_{NA} = \dot{q}^S - v^L\dot{q}^L - v^K\dot{q}^K - v^{II}\dot{q}^{II} \qquad (8)$$

The national accounts based MFP measure will be biased, depending on the difference in growth in sales and margin volumes. The difference between the two MFP measures can be gauged from equations (5) and (8):

$$\dot{A}^M_{NA} - \dot{A}^M = \dot{q}^S - \dot{q}^M = \frac{w^C}{w^M}\left(\dot{q}^C - \dot{q}^S\right) \qquad (9)$$

In case the volumes of goods purchased for resale ($\dot{q}^C$) grew slower than the volume of sales ($\dot{q}^S$), as in the bicycle example given above, MFP growth based on national accounts data will be underestimated. In this paper we will study whether this bias exists for the retail sector and differs across countries, by measuring not only growth in sales volumes, but also the growth in the volume of goods purchased for resale.

A third alternative model to measure multifactor productivity is based on value added. It is given by

[4] This example is taken from Triplett and Bosworth (2004). See Oi (2000) for more examples.

[5] This is analogue to the relationship between MFP measured on a gross output and a value added basis as outlined by Baily (1986).

[6] Although there were a wide variety of methods in use in OECD countries in the estimation of real trade output up to the beginning of the 1990s (see OECD 1995), a rapid convergence of methods has taken place since. Nowadays most countries in the OECD apply this methodology for measuring margin volumes. A minor part of trade output is represented by the output of specific services, e.g. repairing and intermediating services. These services are deflated directly by a corresponding price index. Oi (1992) and Triplett and Bosworth (2004, chapter 8) provide a specific review of measurement issues in U.S. retailing and Eurostat (2001) provides a useful general discussion of the problems in measuring real output in the trade sector.

$$q^{VA} = H(q^L, q^K, T) \qquad (10)$$

Under the standard assumptions, MFP based on value added is given by

$$\dot{A}^{VA} = \dot{q}^{VA} - u^L \dot{q}^L - u^K \dot{q}^K \qquad (11)$$

with u^L the share of labour compensation in value added, and similarly for capital. As in the case of the margin model, when the change in value added volume (q^{VA}) is measured by means of double deflation according to

$$\dot{q}^{VA} = \frac{1}{v^{VA}} \left(\dot{q}^M - (1 - v^{VA}) \dot{q}^{II} \right) \qquad (12)$$

with v^{VA} the share of value added in margin, there is a simple link between MFP growth in the value added model and MFP based on the other models as follows:

$$\dot{A}^{VA} = \frac{1}{v^{VA}} \dot{A}^M = \frac{1}{w^{VA}} \dot{A}^S \qquad (13)$$

with w^{VA} the share of value added in sales. Standard international practice in the OECD is to measure value added with double deflation. On of the few countries which deviates from this norm is the UK. In Section 5, UK value added is re-estimated using double deflation techniques.

Finally, output and inputs are aggregates from more detailed data. Growth in aggregate sales can be written as a weighted average of sales growth in detailed trade industries *j* ($\dot{q}_j^S$) as follows

$$\dot{q}^S = \sum_j w_j^S \dot{q}_j^S \qquad (14)$$

with w_j^S the share of industry *j* in total sales. Similarly, growth in aggregate input X (capital, labour, intermediate inputs or goods purchased) can be written as a weighted average of detailed input *x* growth ($\dot{q}_x^X$) as follows

$$\dot{q}^X = \sum_x w_x^X \dot{q}_x^X \qquad (15)$$

with w_x^X the share of input *x* in total input X costs: $\sum_x w_x^X = 1$. Examples of detailed inputs include various types of capital (ICT and non-ICT asset types) and intermediate inputs (wrapping paper, advertising, legal services etc.). This will be used in Section 5 when calculating MFP.

3. Problems with productivity measures based on national accounts data

In the previous section we noted two problems with productivity measures based on national accounts data. First, increasing international incomparability of sales measures. Second, the lack of data on prices and quantities of goods purchased for resale. In this section we focus on the first issue, while the second issue is taken up in Section 4.

In the U.S. statistical system there has been a rapid increase in the use of hedonics in the quality-adjustment of price indices, especially, but not solely, for high-tech goods. This has led to dramatic price declines, for example in the case of computers. This poses problems for international comparisons of output and productivity. Measured sales volumes will be much smaller in countries that do not make use of hedonic methods for measuring IT-goods prices. In Table 2 we provide an assessment of the potential impact of the use of hedonic deflators for IT-goods sales on the comparative volume measures of sales in the trade sector in the U.S. and four EU countries (France, Germany, the Netherlands and the U.K.) during the 1990s. Table 1 shows the shares of ICT goods in total consumption of goods by households for 1995 and 2002 in these five countries. This share is a good proxy for the share of ICT goods in retail sales. The share of ICT goods consumption in the U.S. is not particularly large, and in between that of the European countries. The last column, however, shows that recorded prices of ICT goods have dropped up to four times faster in the U.S. than elsewhere. This confirms the suspicion raised by Gordon (2004) and the European Commission (2004) that the scope for an upward bias in the measurement of sales volume is bigger in the U.S. than in Europe.

Table 1 Share of ICT in total retail sales and growth in ICT sales prices between 1995 and 2002

	Share in goods		*Price change*
	1995	2002	1995-2002
France	3.5	3.8	-5.0
Germany	3.4	2.8	-2.5
Netherlands	4.9	5.3	-3.6
UK	5.2	6.1	-6.6
US	4.2	4.2	-11.5

Note: share refers to consumption of ‘Audio-visual, photographic and information processing equipment’ in total consumption of goods by households
Source: OECD National Accounts, vol. II, supplemented with national sources

A straightforward way to obtain an impression of the size of the bias in trade sales due to the use of hedonic ICT goods deflators is by simply removing those retail and wholesale industries which mainly sell ICT goods and compare only the sales volume of non-ICT goods trading industries. This is done by for example Manser (2004) and the European Commission (2004). However, such exercises will provide an upper bound estimate of the bias, basically assuming that trade industries that sell ICT do not make an above-average contribution to sales growth, which is unlikely. A more refined approach is to utilize information on physical quantities of ICT goods sold and estimate a price index which is unadjusted for quality. This is possible for the U.S. The *Current Industrial Reports*, published by the U.S. Census Bureau, provide information on quantity and value of manufacturing shipments of a series of products. Using these data we can track the average price (unit value) of, for example, a personal computer, without correcting for quality changes.[7] Value shares are used to Törnqvist aggregate unit value changes across products. This unadjusted price index can be used in deflating sales instead of the official quality-adjusted ICT deflators.[8] The difference between real sales growth using the official and alternative deflator is shown in Table 2.

Table 2
The impact of quality-adjusted sales prices of ICT goods on sales volume growth in U.S. wholesale and retail trade, 1995-2002 (average annual growth rates)

	Wholesale trade	Retail trade
Real sales growth:		
Using official quality adjusted prices	4.2	4.6
Using unit value changes	2.6	3.9
Excluding ICT stores (a)	2.5	3.6

(a) ICT stores in wholesale trade refer to commercial equipment (NAICS 4234) and electrical and electronic goods (NAICS 4236). In retail trade, ICT stores refer to electronic and appliances stores (NAICS 4431) and electronic shopping and mail order houses (NACIS 4541).
Source: BLS Industry Program unpublished data and U.S. Census Bureau's Current Industrial Reports (various issues).

Real sales growth using our alternative unit value deflator comes out considerably lower than the official sales growth in both wholesale and retail trade. BLS figures show real sales growth of 4.2 percent in wholesale and 4.6 percent in retail trade, but our alternative figures come out at 2.6 and 3.9 percent respectively. The share of ICT-goods in total retail sales is simply too small to have a large impact on measured retail output. However, wholesaling of ICT goods accounts for a larger share of total sales than retailing of ICT goods. This is because wholesaling includes ICT-goods exports and deliveries of ICT to the business sector that invests in ICT. Both exports and deliveries to business are sizeable flows in addition to domestic retailing.

We also looked at sales growth in all trade industries excluding those that predominantly sell ICT products as suggested by the European Commission (2004). As Table 2 shows, our adjusted real sales growth is an intermediate case between the BLS figures for the total trade sectors

[7] Chun and Nadiri (2002) use similar data to come up with a measure of 'quality change' in the computer industry.
[8] In wholesale and retail trade, products from the computer industry are important, representing between 2 and 2.5 percent of sales in retail trade and 4-4.5 percent of sales in wholesale trade. Semiconductors make up an additional 2.5-3.5 percent of sales in wholesale trade. For the computer industry, we have information on unit values for a maximum of 68 products, while for the semiconductor industry around 150 products are covered, although not for each year. We also used quantity and value data on imported computers and semiconductors to calculate a combined index on domestic and imported price changes. Results were very similar, so they are not reported here.

and the figures for all industries excluding sales of ICT goods. As argued above, the latter approach provides indeed an underestimation of U.S. trade output, but the message is the same.

Unfortunately due to data limitations for detailed trade industries in European countries, the exercise above could only be done for the U.S. In comparison to Europe, this estimate of the impact of the intensive use of quality adjusted ICT prices in the U.S. probably reflects an upper bound. This depends on how quality changes in ICT products in European countries are measured. Indeed various studies suggest that many European countries at least take some account of rapid quality changes in ICT products. But as shown in Table 1, this is much less than in the U.S. Coupled with the fact that the ICT goods producing sector in the U.S. is much bigger than in Europe, it seems safe to say that at the least in wholesaling the overestimation in the U.S. is much bigger. We will therefore rely on our unit-value deflated sales growth in U.S. wholesaling when comparing trade productivity in Section 5.

In fact, international differences in deflation methods are not only confined to ICT goods. The problem is of a more general nature: when the measured change in sales volume is mainly due to changes in the quality characteristics of the traded goods rather than the physical volume of their sales, and countries differ in their quality adjustments, international comparability is compromised. This is true for ICT sales, but also true for sales of other goods whose prices are constant quality measures. Given the increased attention of statistical agencies for improved measurement of quality changes in price indices, this problem is getting worse over time. To the extent that the U.S. is more advanced in terms of developing quality-adjusted price indices the upward bias in U.S. trade sales volume measures compared to Europe may go beyond the bias created by recorded sales of ICT products. Whether this is the case for retailing, is the topic of the next section.

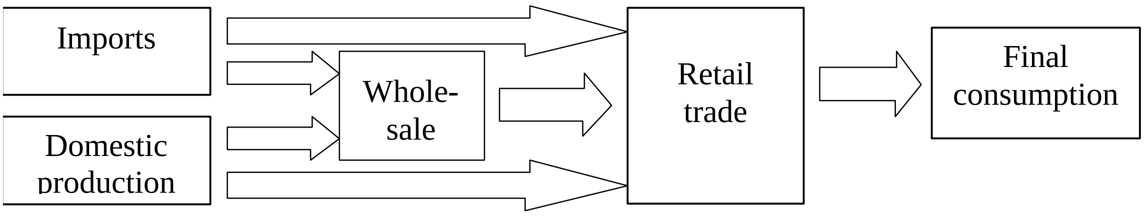
4. Double-deflated measures of trade margins

From a multifactor productivity perspective, deflation of sales by a quality-adjusted price index poses no particular problems as long as inputs are also measured in constant quality terms (Triplett, 1996). Indeed if goods purchased are deflated separately with indexes that make the same quality adjustment as the price indices of goods sold, double-deflated measures of the margin will not suffer from the problem described above. If double-deflated measures of margins are to be preferred in theory, why do statistical offices not employ this technique in practice? An important practical reason is that price data, especially of purchases of goods for resale is scarce and generally not available at a sufficiently detailed level. Moreover when purchased goods account for a large share of total sales, and when the reliability of the price indices for purchased goods is not very high, the estimate of the margin volume, which is a residual, see equation (6), can become highly erratic (Hill, 1971). Admittedly, data availability is far from perfect and various assumptions need to be made in order to be able to derive double-deflated measures of trade margins. But we feel that it is time to reconsider this technique, even with imperfect data, given the increasing weakness of the current methodology.

Ideally, we would like to double deflate wholesale and retail margins separately. This would require four sets of prices: wholesale purchase and sales prices, and retail purchase and sales prices. Unfortunately these are not available for any country. Wholesale sales prices and retail purchase prices are often lacking. In addition, one needs the value of sales and purchases by product group. These are much more widely available for retailing than for wholesaling. Therefore we only apply the double deflation technique to retailing.

For double deflation of retail margins, two sets of prices are needed: retail sales prices and retail purchase prices. The main problem is the derivation of retail purchase prices. Retailers purchase goods for resale mainly through wholesalers. But increasingly, the wholesale sector is bypassed and goods are acquired directly from domestic and foreign manufacturers. In Figure 2 we provide a stylised view of the flow of goods through the retail trade sector.

Figure 2
Simplified flow of goods between retail trade and production sectors



We define a price for purchased goods by the retailer through matching a producer price index (PPI) and an import price index (IPI) to each final consumption good category *i*. For the retail trade sector, the change in the purchase price ($\dot{p}^C$) is calculated as:

$$\dot{p}^C = \sum_i \left[w_i^I \, \dot{p}_i^I + \left(1 - w_i^I\right) \dot{p}_i^D \right] \tag{16}$$

with $\dot{p}_i$ denoting a price change of product category *i*, w_i^I the share of imports in total purchases and superscripts *C, I* and *D* denoting respectively total purchases, imported purchases and domestic purchases. The share of imports in total purchases of each type of good is determined using input-output tables, under the assumption that the share of each goods category in total purchases equals the share of each category in total consumption.[9] Although the estimated sales and purchases prices correspond to household consumption on goods, one may assume that these are the relevant prices for the retail trade sector in each country. Note that by defining the retail purchase price as a

[9] Note that with this assumption we make a link between products purchased for resale and products sold. Because we do not have purchase shares, we have to rely on sales, proxied by consumption, shares instead. Hence, the prices of products purchased are not independently measured from prices of sales, as they ideally should.

weighted average of domestic production and import prices, we ignore the wholesale sector. To be more precise, we assume that changes in wholesale sales prices are proportional to changes in wholesale purchase prices (see below for more discussion).

Prices of retail sales and purchases can be used to derive implicit prices for margins ($\hat{p}^M$) using the dual price equivalent of equation (6):

$$\hat{p}^M = \frac{1}{w^M}\left(\hat{p}^S - (1-w^M)\hat{p}^C\right) \qquad (17)$$

with w^M the share of the margin in total sales.

As in the previous section, our empirical analysis covers France, Germany, Netherlands, United Kingdom and the United States. For each of these countries, National Accounts statistics provide information on household consumption by type of goods in current and constant prices. The level of detail varies between countries, but we could use consumption data for in between 20 and 40 goods categories, such as food products or clothing. Our measure of the margin to sales ratio is based on a benchmark estimate of retail margin to sales ratios derived from industry surveys and censuses for the retail sector for each of the countries for 1997 (Timmer and Ypma, 2005). These estimates are extrapolated using gross margin to sales ratios from census sources.[10]

In Table 3 we present the results of our double deflation procedure for retail margins.[11] The table presents the sales price of household consumption goods, the corresponding purchase prices and the contributions from import and domestic price developments for the period from 1987 to 1995, and the period from 1995 to 2002. We also present the double-deflated margin prices using the retail trade margin-to-sales ratios as weights according to equation (17).

The table reveals considerable heterogeneity between the countries as well as between the two periods. In the period 1987-1995, retail sales prices in the UK and the U.S. grew faster than in the rest of Europe. This was driven by much more rapid growth in purchase prices of both domestically produced goods and imports. But after 1995, this was reversed. Anglo-Saxon sales prices grew less than elsewhere, thanks to a sharp decline in purchase prices (especially imports). When looking at the development of the margin prices, a distinction can be made between Germany, the U.K and the U.S. on the one hand, and France and the Netherlands on the other hand. Whereas in the first group of countries, the margin prices decelerated, this was not, or much less so, the case in the other countries.

[10] If no reliable data on retail sales could be found for some years, sales were extrapolated using the growth rate of household consumption on goods.
[11] Note that we use the ISIC rev 3 definition of retail trade (ISIC 52). This industry does not include retail trade of automobiles and gasoline. Hence these items are also excluded from household consumption.

Table 3
Sales, purchases and margin prices for household consumption goods

	Sales prices	Purchase prices	*Purchase price contribution by* Domestic products	Imports	Implicit Margin prices
	1987-1995				
France	1.9	0.7	0.9	-0.2	4.3
Germany	1.7	1.3	1.3	-0.1	2.5
Netherlands	1.0	0.4	0.5	-0.1	2.1
UK	3.3	4.1	3.2	0.9	1.6
US	2.0	2.2	1.7	0.5	1.7
	1995-2002				
France	1.4	0.5	0.7	-0.2	3.4
Germany	0.7	1.0	0.9	0.1	0.3
Netherlands	1.5	1.1	1.0	0.0	2.2
UK	0.2	0.3	0.7	-0.5	0.3
US	0.5	0.7	0.9	-0.2	0.0

Note: household consumption on goods excludes automobiles and gasoline consumption.
Sources: Sales prices: household consumption expenditure prices (National Accounts); Import prices of purchases: import price index (National Accounts and other national sources); Domestic prices of purchases: gross output and producer price indexes (National Accounts and other national sources); Import shares in purchases: Input-Output tables from national sources, Retail margin-to-sales ratios: Timmer and Ypma (2004) for 1997 extrapolated on basis of retail census and surveys.

Using double-deflated margin prices, alternative estimates of the growth rates of margin volumes in retailing can be computed according to equation (6). These are shown in Table 4. This table compares our experimental estimates with official margin volume growth from the National Accounts[12] for 1987-1995 and 1995-2002. In the case of the United States, the difference between the national accounts-based margin measure and the double-deflated measure is quite small for both periods. If anything, double-deflated margin growth rates are even higher. For the Netherlands, it is suggested that the official estimate is slightly upward biased. For Germany a sizable downward bias is found for the latest period. Margins increase at least 1 %-point faster than suggested by the national accounts estimates. For France, the opposite is found: our double-deflated measures suggest much slower growth in retail services than the national accounts measures (at least 2 %-points). UK retail margin growth is exceptionally high, especially according to our double-deflated

[12] The real growth rate of margins in the National Accounts is not exactly equal to the real growth of sales. This is due to the fact that the proxy measurement of margin volume by sales volume is normally implemented at a detailed industry level so that changes in the sales shares of different trade industries with different margin-to-sales ratios is reflected in the aggregate measure of the margin volume. But generally this shift effect is very small (Eurostat, 2001).

measure. Summarising, this exercise would suggest that comparisons based on national accounts data do not upwardly bias U.S. growth when comparing it to the European countries. In Germany, the UK and the U.S. national accounts figures underestimate growth, while in France and the Netherlands growth rates are overestimated.

Table 4
Growth of gross margins volumes in retail trade, National Accounts versus double deflation, 1987-2002 (average annual growth rates)

	1987-1995		1995-2002	
	National Accounts	*Double deflated*	*National Accounts*	*Double deflated*
France	2.3	0.1	2.3	-0.2
Germany	1.4	1.5	1.2	2.4
Netherlands	2.9	2.6	2.7	2.2
UK	n.a.	6.3	4.6	6.5
US	3.1	3.1	4.2	4.9

Sources: National Accounts, UK *Annual Business Inquiry* and Table 3.

Notes: Germany refers to 1991-1995 instead of 1987-1995. National Accounts for Germany based on real value added and an estimate of real intermediate input assuming the price change of intermediate inputs in retail trade is equal to the price change for total trade; UK National Accounts estimate based on ONS, *Index of distribution*. U.S. retail includes repair services to make it comparable to European classification.

It needs to be stressed that these estimates based on double-deflated margin prices are of an experimental nature, and require a careful assessment of potential (systematic) errors in our results. One of the reasons for national statistical offices to avoid double deflation in obtaining the volume of the margin for distributive trade industries is that all possible measurement errors in both sales and purchases prices will end up in the margin prices. As a result, double-deflated margin prices are more sensitive to price measurement errors than sales prices. Double-deflated measures can be highly volatile as a result. This does not make double deflation useless. On the contrary, double deflation is used for estimates of real value added growth in many other industries in the National Accounts. It is only that the double deflation of margins in trade sectors is more susceptible to this problem than other industries as margin-to-sales ratios can be rather low. In Appendix Table 2 we give an indication of the severity of this problem. It gives the standard deviation of annual margin volume growth rates over the period 1987-2002 for our double-deflated estimates and those given in the National Accounts based on real sales. As was to be expected, the volatility of the double-deflated margins is higher than that of real sales. But differences are not very pronounced, except for the Netherlands and the UK

The usefulness of double deflation depends critically on the availability of price indices for goods purchased. In particular, these prices need to be adjusted for quality in the same way as prices of goods sold. These series are not yet available and our estimates can only be rough. Another important potential measurement error in our procedures is that we allocate all the change in margin prices to retailing, ignoring the role of changes in wholesale margins. As explained above, we needed to assume that the change in wholesale purchase and sales prices were the same. So if, for example, wholesalers have managed to let their margin prices grow less than their purchase price, our estimates of retail margin price changes are downwardly biased. On average, wholesale margins make up about a quarter of the total margin on consumer goods, so the potential effect is limited. But without data on wholesale sales prices, this issue cannot be resolved. Another serious data weakness is the way we allocated producer and import price indices to products consumed by households. Indices are allocated at a relatively aggregate level (at maximum 40 product categories), so mismatches cannot be ruled out. More detailed consumer, producer and import prices might alleviate this problem.[13]

5. Multifactor productivity comparisons

In this section the implications of the new estimates of wholesale sales and retail margins for comparisons of trade productivity between the U.S. and Europe are discussed. In order to do this, we had to solve a number of other comparability problems first. These had to do with the measurement of value added in the national accounts of the UK and the U.S. In Appendix 1 the adjustments made are described in full. Here they will be touched upon only briefly. Standard international practice is to derive value added growth by subtracting growth of intermediate inputs from growth of margins. However, this is not done in the official UK National Accounts (Sharp, 2003). We prepare new estimates of intermediate input use in UK trade and find that the official value added growth rates are too high. For the U.S. we made adjustments to bridge the European industrial classification NACE and the North American industrial classification (NAICS). This involved the reallocation of trade industries and of value added for the inputs from the sector 'management of companies' (see Appendix 1 for details).

In Table 5 we present new estimates of labour and multifactor productivity growth based on our harmonised output measures. The first column in Table 5 gives our alternative estimate for value added growth in the period 1995-2002 for the U.S. and the 4 European countries for total trade, and the three trade industries separately. These estimates differ in most cases form the official value added growth rates as given in the national accounts. Estimates for the UK and U.S. are adjusted as described above. In addition, U.S. wholesaling output is adjusted for the prices of ICT goods as discussed in Section 3. All retail trade value added estimates are based on our double-deflated margins as discussed in Section 4, rather than single deflated sales as in the National Accounts.

In Column 2 growth rates of labour productivity (gross value added per hour worked) based on our alternative value added measures are presented. It is shown that labour productivity growth in the U.S. trade sector has been much higher than in Europe. In the period 1995-2002, average annual growth has been 4.4% per year compared to 2.5% in the U.K., 2.3% in the Netherlands and

[13] See Timmer, Inklaar and van Ark (2005) for a detailed study of 12 U.S. retailing industries.

1.8% in Germany. Labour productivity growth in France was even negative (-0.2%). This U.S. lead can also be noticed for the three trade industries, albeit differences are less pronounced. In retail trade labour productivity growth in the UK was even higher than in the U.S.

In column 3, multifactor productivity growth rates are given. These are based on the value added model given in equation (11) using updated capital service growth rates from Inklaar, O'Mahony and Timmer (2003).[14] The latter study presents capital service growth rates based on 6 asset types, including ICT hardware and software for the trade sectors using equation (15). Based on multifactor productivity comparisons, superior U.S. productivity performance is much less pronounced. MFP growth in the total trade sector in the U.S. is higher than in all European countries but not out of range: 2.5 % in the U.S. compared to 2.1% in the Netherlands, 1.8% in the U.K., 1.2% in Germany and –0.6% in France. The diminished U.S. lead in productivity when taking into account capital services indicates that a sizeable part of U.S. growth has been fuelled by high investments, especially in ICT assets. This is particularly true for wholesaling: U.S. labour productivity growth was 3.9% while MFP growth was only a mediocre 0.9%.

In the last column MFP growth based on official value added figures from the National Accounts are given. It can be seen that our adjustments to value added growth had some important implications for the assessment of comparative growth in the U.S. and the EU. Based on official figures, the U.S. is clearly ahead of all European countries in MFP growth, leading by 1.2 percentage points over the Netherlands, 1.8 over the U.K., 2.9 over France and 3.2 over Germany. According to our alternative estimates this lead is much smaller. In addition, the ranking of the European countries are affected. German growth rates appeared to be much higher than suggested by the official figures, while official French growth rates seem to be highly overestimated.

Looking at the MFP estimates at the trade industry level, the biggest adjustments are made for the UK While official figures seem to overestimate productivity growth in wholesaling and motor trade, retail productivity growth is highly underestimated. At the aggregate level these adjustments appear to cancel out. As a result, according to our estimates, UK retailing productivity performance is even better than in the U.S., while wholesaling is seriously lagging behind. Also German retailing appears to perform much better than suggested by the official figures, while French retailing productivity performance is exceptionally poor.

[14] In this paper we do not deal with issues concerning factor input measurement. Although there are problems in the international comparability of factor input measures in distributive trade too, they are relatively minor compared to problems with value added measures.

Table 5 Comparisons of productivity growth, 1995-2002

	Alternative estimates				National
	Value added	Labour productivity	MFP		accounts based MFP
Motor vehicle trade and repairs					
France	0.7	-0.4	-0.4		-0.4
Germany	0.3	-1.0	-1.1		-1.1
Netherlands	2.3	1.3	1.0		1.0
UK	2.2	2.7	1.2		2.2
US	4.7	4.2	2.7		n.a.
Wholesale trade, except motor vehicles					
France	2.0	1.0	0.7		0.7
Germany	0.5	1.6	0.6		0.6
Netherlands	5.4	3.5	3.3		3.3
UK	-0.1	-1.8	-2.3		0.4
US	3.9	3.9	0.9		2.7
Retail trade, except motor vehicles					
France	-1.0	-1.4	-2.0		1.0
Germany	3.0	3.2	2.7		0.7
Netherlands	1.7	0.3	0.3		1.2
UK	7.6	6.4	5.8		2.8
US	6.0	5.2	4.2		4.6
Total trade					
France	0.5	-0.2	-0.6		0.7
Germany	1.5	1.8	1.2		0.4
Netherlands	3.9	2.3	2.1		2.4
UK	3.7	2.5	1.8		1.8
US	4.9	4.4	2.5		3.6

Notes and sources: Multifactor productivity measures based on the value added model, see equation (11); Value added for national accounts MFP estimate from GGDC (2004) *60-industry database*, which is based on National Accounts data. Alternative value added for industry 50 and 51 from GGDC (2004) except for UK and U.S. U.S. 50, UK 50 and UK 51 from Appendix Table 1. U.S. 51 real sales growth based on adjustment for ICT prices, see Table 2; Alternative value added for industry 52 based on double-deflated margins from Table 4 and intermediate input growth from GGDC (2004) for France, Germany and Netherlands, and from Appendix table 1 for UK and U.S. Real value added growth for Germany in Wholesale trade and Retail trade is estimated assuming the price change of intermediate inputs in each of these industries is equal to the price change of intermediate inputs for total trade; Hours worked from GGDC (2004) *60-industry database*. U.S. Labour input is adjusted by adding an estimate of hours worked in headquarters for trade industries; Capital service growth and share of labour compensation in value added from Inklaar, O'Mahony and Timmer (2003).

Finally, we look at the differences in comparative productivity performance when alternative multifactor productivity measurement methods are used. As discussed in Section 2, multifactor productivity growth rates can be estimated on the basis of a full production model using sales as the output measure, or more restricted models based on margin or value added. When margins and value added are measured on the basis of a double deflation procedure, MFP growth rates based on the various models are scaled estimates of each other. This is indicated in equations (9) and (13). The ratio of MFP growth based on sales and based on margins is the margin-to-sales ratio. Similarly, the ratio of margin-based MFP and value added based MFP is given by the value added-to-margin ratio. The latter ratio conveys interesting information by itself. In the last two columns of Table 8 the ratio is given for 1995 and 2002. The striking finding is that the increase in this ratio in the U.S. while it is decreasing in Europe. This suggests dramatic improvements in the usage of intermediate inputs that could be taken as a sign of pervasive reorganisation of the production process in the U.S. trade sectors, a process that has not taken place in Europe.
In the first three columns of Table 8 MFP rates based on the three alternative production models are presented. As to be expected, MFP growth rates based on sales are lower than those based on margins, which in turn are lower than those based on value added. The main conclusion to be drawn from these results is that the use of a particular production model is inconsequential for international comparisons of productivity. Margin-to-sales and value added-to-margin ratios do not differ greatly across countries, so the ranking of each country in terms of productivity performance is not affected: the U.S. is leading according to all models.

Table 6 Alternative estimates of multifactor productivity growth, 1995-2002

	Multi factor productivity growth based on				*Share of value added in margin*	
	Sales	Margin	Value added		1995	2002
France	-0.10	-0.42	-0.62		70%	66%
Germany	0.16	0.73	1.19		63%	62%
Netherlands	0.27	1.27	2.13		62%	59%
UK	0.24	0.95	1.84		54%	52%
US	0.41	1.67	2.57		63%	67%

Sources: see Table 5.

6. Concluding remarks

In this paper we provide an assessment of whether productivity growth differentials between the U.S. and Europe in the distributive trade sector are real or mainly a statistical myth. We have argued that at times of rapid changes in retail and wholesale formats and improvements in the quality of products and distributive services, official measures of trade output are becoming increasingly obsolete. Using an experimental double deflation procedure, we constructed alternative estimates of retail trade productivity taking into account purchase prices of goods sold. We also tried to harmonise productivity measures across Europe and the U.S. in the wholesale trade industry by adjusting U.S. wholesale sales volumes for the upward bias due to extensive use of quality adjusted pricing of ICT-goods sales. In addition, UK and U.S. official value added figures were adjusted in line with European conventions. Our main finding is that the multifactor productivity growth lead of the U.S. over Europe is real and not a statistical myth. However, the gap is smaller than suggested by estimates based on national accounts data. Looking at the detailed trade industries, U.S. MFP growth is leading in motor vehicle trade. In retail trade productivity growth is also much higher than in Europe, except for the UK The main upward bias in the official estimate can be found in wholesaling. According to our estimates, MFP performance in U.S. wholesaling is not out of line with the other countries, while it was clearly outperforming Europe on the basis of national accounts data.

It should be stressed that the estimates in this paper are of an experimental nature and mainly developed for assessing the claim that the difference in the U.S.-EU productivity gap in distributive trade is not real but a statistical myth. There are still important data issues to be resolved before our estimates can be treated as a genuine alternative to the present national accounts-based estimates. For example, the increasing complexity of discount practices put a high demand on the data, and may be plea in favour of a direct measurement of margin prices rather than our double deflation approach. Currently some experimentation is going on with product margin prices by asking stores the difference between the sales and purchase price of a particular product, but on a very limited scale.[15] In addition, neither the common national accounts methods nor our data exercises are able to deal directly with the actual improvements in service quality. The quality of services is dependent on store characteristics like the convenience of the location of the store, the variety of goods on offer, information and swiftness of service, but also includes ancillary services such as credit facilities, delivery, after-sales service etc. Econometric studies have tried to measure this bias and generally conclude that trade service quality has improved in the U.S. (see e.g. Betancourt and Gautschi 1993, Ratchford 2003). However, comparable studies on these issues for Europe have not been made so far. One way to measure quality change would be to directly measure price margins of specific items and to correct these for quality changes by collecting characteristics on the store in which the items are sold.

Clearly, current statistical practice is not well suited for studies of productivity growth in the distributive trade sector. The development of quality-adjusted price indices for margins or for goods purchased for resale would be a major step forward in this process.

[15] Recently, the BLS in the U.S. has introduced a new initiative to measure margin prices in its PPI program by surveying directly the difference between the sales price of a specific item and its acquisition cost (Manser, 2004). Also in Europe experimentation is taking place, for example in Finland and Norway (Eurostat, 2001).

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Appendix 1 Adjustment of U.S. and UK value added

Until recently, in the national accounts of most OECD countries, current value added and intermediate consumption were derived using the income or production approach. The choice of approach differed across countries. In recent years, most countries have merged these approaches into a unified system by using supply and use tables (SUT), which are integrated with the National Accounts industry tables. In this approach real value added by industry is calculated by a double deflation procedure in the context of balanced SUTs. Intermediate inputs are separately deflated and the volume growth of value added is derived as a residual by subtracting growth in intermediate input from growth in real output. In most European countries (including France, Germany and the Netherlands) and the U.S. this system is in place.[16] One of countries which deviates from this international practice is the United Kingdom. In the UK real value added in the National Accounts is derived by weighting real output series at a detailed level with base year current value added shares (Sharp 2003). In the case of trade output, these real output series are proxied by real sales. Therefore the UK value added measure does not take into account changes in the use of intermediate inputs. In essence, they are real sales measures. In Appendix Table 1 we provide an alternative value added measure of UK trade by subtracting growth in intermediate input from growth in real margin. This is based on the double deflation methodology as used in other countries. To this end we calculated a volume measure of intermediate inputs for wholesaling and retailing, based on annual Use-tables and a set of gross output deflators by industry.[17] An official volume measure of trade margins is not available. We followed the standard procedure in other countries and proxied margin volumes by sales. This real sales index was taken from ONS, *Index of Distribution*, which underlies the *Blue Book* (National Accounts). Using equation (12), real value added growth is derived on the basis of real sales and real intermediate consumption. Our double-deflated value added measures give a different picture of growth in the UK trade sector. Total trade value added growth is estimated as 2.3% instead of 3.6%. This is mainly due to our downward correction for the value added growth in wholesaling: from 2.6% to –0.1%.

Also for the U.S. we had to make some adjustments to the official National Accounts figures to make them comparable to the European numbers. The line U.S. (official) gives the data according to the latest vintage of real GDP by industry data. This is taken from BEA, *National Income and Production Accounts* (NIPA) released in November 2004, based on the new North American Industrial Classification Standard (NAICS) classification.[18] Comparisons between NAICS and the industrial classification used in Europe, NACE revision 1, shows that the industries included in the trade sector differ between the two classifications. In NAICS, repair services are not

[16] In the U.S. statistical system the switch to an integrated SUT framework has only very recently been made (Moyer et al. 2004).

[17] Sectoral output deflators have been derived by subtracting growth of real output from growth of nominal output. Real output by industry can be derived from the National Accounts series on value added volume changes. As explained in the main text, value added volume measures are in essence real output measures. Nominal output growth can be derived from the Use-tables.

[18] Previous productivity studies such as Triplett and Bosworth (2004) and Jorgenson, Ho and Stiroh (2002) relied on a previous vintage of NIPA data based on the old SIC classification.

included in the trade sector. We added figures for NAICS repair services to NAICS trade to get a NACE based trade sector. In particular, NAICS industry motor vehicle repair was allocated to NACE Motor vehicle trade, and NAICS industry repair of household goods to NACE Retail. NAICS motor vehicle trade was moved from NAICS Wholesale trade to NACE Motor vehicle trade.

In addition, in NAICS a new sector is being distinguished called management of companies and enterprises. It consists of two industries: offices of bank holding companies and corporate, subsidiary, and regional managing offices. The latter sector consists of establishments that administer, oversee and manage establishments of a company or enterprise. They provide various auxiliary services to the operating establishments of a company. Wholesale and especially retail are industries where there are a lots of stores that have a corporate or regional headquarters that provides the "back office" services to the stores. For example, Wal-Mart has lots of stores all over the country, but their accounting, payroll, advertising functions are carried out, not by the individual stores, but by a regional headquarters. Previously, under the U.S. SIC classification, these activities would have been included in the output of the trade sector, as they are in the European statistical system. But under NAICS they are recorded as output of the management sector and as intermediate input in the trade sector, effectively bringing down the value added generated in the trade industries. In the row U.S. (after reallocations) margin and value added measures for the trade sector have been corrected for this problem, based on equation (14) and using data from the 1992 and 1997-2002 BEA Input-output tables.

Appendix Table 1
Growth of real margins and value added in U.S. and EU, 1995-2002

	Total trade NACE 50-52		*Motor vehicle trade NACE 50*		*Wholesale trade NACE 51*		*Retail trade NACE 52*	
	Margins	Value added	Margins	Value added	Margins	Value added	Margins	Value added
UK (official)	n.a.	3.6	n.a.	3.2	n.a.	2.6	n.a.	4.6
UK (double deflated value added)	3.6	2.3	3.2	2.2	2.6	-0.1	4.6	4.4
US (official)	4.7	6.3	n.a.	n.a.	4.1	6.1	5.2	6.5
US (after reallocations)	4.4	6.0	3.6	4.7	4.9	7.6	4.2	5.0

Sources: UK (official) and UK (double deflated) based on ONS *Blue Book, Use tables* and ONS, *Index of Distribution*. U.S. based on BEA, *GDP by Industry* (released November 2004). In the US, intermediate input growth for all three trade industries is estimated using data from the Business Expenses Survey, with total intermediate inputs at current prices benchmarked on the National Accounts. Intermediate input growth in the trade industries in the U.S. is adjusted by excluding the contribution to intermediate input growth of Management of Companies (headquarters, NAICS 55). Motor vehicle margin growth in the U.S. is based on real sales from the BLS for retail and wholesale motor trade and output growth for motor vehicle repairs.

Appendix Table 2 Standard deviation of annual growth rates of retail margin volumes, National Accounts versus double-deflated prices, 1987-2002

	National Accounts	*Double deflated*
France	2.6	2.9
Germany	1.8	2.6
Netherlands	1.7	5.5
UK	1.2	4.5
US	2.3	2.3

Note: Germany refers to 1991-2002; UK refers to 1995-2002.
Source: Table 4.